

to the arrival first of the emergent wave, followed by the progress outwards and along the surface of others from the seismic vertical. On the contrary, those in the mesoseismal area felt the blow and report apparently simultaneously; the walls fell before any attempt at an escape could be made. It appears therefore that the sound waves travel faster than those of the earth, though the difference in arrival is inappreciable at short distances from the seismic vertical.

Since the principal shock the following minor ones have been felt:—

July 29, 1883	Slight shock in the morning?
Aug. 1,	"	...	" 3.10 p.m.
" 1,	"	...	" 4.50 "
" 1,	"	...	" 11.15 "
" 2,	"	...	" 2.30 "
" 3,	"	...	" 1.15 or 2.15 ¹
" 8,	"	...	" 10.40 a.m.
" 12,	"	...	" morning?

The accessibility of the island, the advanced state of our geological knowledge of it, and the small extension of the earthquake area, make it most suitable and convenient for the study of its terrestrial movements. What is required is a number of seismographs scattered over the island, which should be capable of registering azimuth, angle of emergence or molecular velocity, with the exact time of each movement so as to obtain velocity of transmission. These should be distributed in two circles around the seismic vertical, and should be at least sixteen in number, eight being in each circle, one or more for registering vertical waves to be placed along the seismic vertical. Accurate thermometric measurements of the principal fumaroles and mineral springs to be registered hourly, and if possible some device for measuring quantity of outflow of mineral waters, and pressure of vapour in fumaroles. To these it might be useful to add microseismic observations. The changes in sea level would be of interest if compared with those of Naples.

The principal expense would be providing the instruments, which could be placed in caves cut in the solid tufa, of which there are hundreds in the island that could be obtained for almost nothing, if not entirely free of expense.

By such means we might study the true nature of these shocks, the progress of the focus towards the surface, and verify whether any premonitory signs are to be depended upon preceding an earthquake.

I would impress on all persons charitably inclined that money spent on such an enterprise would be productive of far more good than when distributed to be spent in rebuilding the perilous houses of masonry in preparation for another catastrophe. Not six days after the terrible event, masons were at work repairing the most dangerous walls, and many inhabitants have already returned to reside in their fissured and crumbling abodes. Besides, if another shock occurs more violent than the last, a large number of additional localities would suffer, such as Forio and Ischia, besides the villages on the south coast of the island.

H. J. JOHNSTON-LAVIS

P.S.—In collecting evidence of the Ischian earthquake a very remarkable fact was communicated by Mr. Petersen, the engineer of the Zoological Station at Naples. Whilst dredging on the north side of the unfortunate island, about opposite the cemetery of Casamicciola, a number of pieces of pumice were found floating on the water, some of them as large as a man's head; they had quite a fresh appearance. The conclusion is that there has been a submarine eruption somewhere near the island. Such would explain the sensations felt on board the steamers and the apparent disturbance of the coast line. On the other hand it is strange that the eruption

left no other signs, and that nothing was observable the next morning. No dead fish were noticed. The pumice might be derived from loose deposits containing that material, which form some of the sea cliffs which were shaken down by the earthquake. Whatever be the real cause, we propose to investigate it thoroughly by dredging and diving, as the water rarely exceeds twenty to thirty fathoms at the most.

H. J. J.-L.

Naples, August 31

THE BERNISSART IGUANODON¹

THE wonderful discovery of remains of Iguanodons made at Bernissart in 1878 caused quite a sensation amongst naturalists at the time, and the publication of the scientific results of that grand find have been awaited ever since with eager expectation. Nevertheless, as five years have elapsed since the discovery was announced, it is well that the memory should be refreshed by a few brief details as to the circumstances of the find itself before the results as to the nature of the Iguanodons themselves, lately made public, are referred to. Bernissart is in Belgium, situate between Mons and Tournai, close to the French frontier. In the spring of 1878, in one of the galleries of a coal mine there, were discovered in Wealden clays a large number of bones. Specimens of these bones were forwarded to Professor P. J. van Beneden, who at once recognised them as belonging to Iguanodon.

It is to M. Fagès the director general of the Bernissart Mining Company that the discovery is due. He interested himself greatly in the matter, and from first to last the mining company has most generously and meritoriously devoted its best resources to the recovery from the depths of the earth in the most perfect condition possible of these most remarkable scientific treasures. It has presented them all to the Royal Museum of Brussels. The actual removal of the specimens from their beds and their transmission to the surface, was performed under the immediate superintendence of Mr. Gustave Arnould, chief engineer, and of M. De Pauw, the latter being the superintendent of workshops at the Brussels Museum, who has since successfully mounted the enormous skeleton shown in the accompanying engraving. So immensely abundant were the remains found to be that Mr. De Pauw assumed for three years the habits of a miner, watching and controlling the removal of every specimen. He invented an ingenious method of hardening the bones *in situ* which prevented their crumbling when exposed to the air, which at first occurred. The bones exposed on the surfaces of the blocks excavated were covered with a coating of plaster for protection, and the masses thus formed were then raised to the surface, a distance of more than 1,000 feet and removed to cellars under the natural history galleries of the Brussels Museum, to be worked out at leisure. M. Dupont, Director of the Museum, confirmed Professor van Beneden's determination of the bones, and at the same time fixed the exact age of the deposits in which they occurred.

Some surprise has certainly been felt by naturalists that so very little information about the Bernissart skeletons has been published during the time which has elapsed since their discovery, but it must be borne in mind that it took three years even to get the rough material out of the pit, and that every mass of matrix containing bones requires a great deal of most careful labour to be expended on it before the bones in it are fully exposed for study. M. L. Dollo, a distinguished former pupil

¹ M. L. Dollo, "Première Note sur les Dinosauriens de Bernissart." *Bulletin du Musée Royal d'Hist. Nat. de Belgique*, T. i. 1882. Deuxième note, *Ibid.*, l.c. Troisième note, *Ibid.*, T. ii. 1883. "Note sur la présence chez les oiseaux du Troisième Trochanter des Dinosauriens et sur la fonction de celui-ci," *Ibid.*, l.c. "Les Iguanodons de Bernissart." *Bulletin Scientifique de pédagogie de Bruxelles*, April 1, 1883, No. 2, p. 25.

¹ Which was much stronger and produced slight damage.

of Prof. Giard of Lisle, was appointed about two years ago as assistant naturalist to the Museum for the purpose of investigating the Iguanodons. He is full of enthusiasm, as an ardent naturalist such as he is well may be with the whole Bernissart material before him. He works incessantly at the subject, but he does not see prospect of publishing the complete monograph on the Iguanodons which he intends to issue sooner than five or six years hence. He will not of course venture to prepare the final monograph until he has the whole of the material concerned before him. He estimates the number of individuals represented by skeletons in the find as twenty-three, two of which belong to the species *I. Mantelli*, and twenty-one to *I. Bernissartensis*. Of these twenty-three, fifteen have as yet been chiselled out of the blocks ready for study, eight remain as yet to be worked at, and although four or five skilled artificers are constantly at work on the specimens progress is necessarily slow. The cellars full of the material present an astonishing appearance. One first enters an extensive, dimly lighted vault, the whole floor of which is covered with large blocks, many still in the condition in which they came from the mine, of all shapes, and lying in all sorts of positions, so closely placed that it is very difficult to get about amongst them to inspect them more closely. All contain huge bones, forming parts of the skeletons of the Iguanodons, often covered up by the protective plaster, but with here a hand, there a foot, elsewhere a range of vertebrae showing out. In an adjoining cellar is the workshop where various blocks are seen in the process of the removal of the matrix, whilst at one end, hung up to stout beams, are the results of the operation, a vast collection of all imaginable segments of the skeletons of Iguanodons suspended in the air, and suggesting the idea of joints of meat in the shop of some Broddingnagian butcher.

As before mentioned, one of the skeletons of *Iguanodon Bernissartensis* has been restored and mounted by Mr. J. F. de Pauw. The specimen is almost entirely complete, only a few phalanges and one or two minor details having required to be reconstructed. It was not found possible to detach the bones from one another before mounting them. They are mostly mounted still joined to one another in sections by the matrix as removed from the mine. It was therefore impossible to give to the skeleton as natural a pose as might have been wished, and as M. de Pauw hopes to accomplish with some of the other specimens more favourably preserved; but taking all circumstances into consideration the present result of his work is a marvellous success, in which it needs a very trained eye indeed to detect anything amiss. The grand skeleton is set up in a huge glass chamber in the court of the Museum. As it stands in the natural attitude of progression of the animal on land, erect on its hind limbs, the top of its snout is at an elevation of a few inches over 14 feet from the ground, whilst from the tip of the tail outstretched behind to a point immediately beneath the tip of the snout the skeleton covers a horizontal space of floor about 23 feet in length.

As soon as M. Dollo set to work on the details of the structure of the Iguanodons, he very wisely determined to publish at once a series of preliminary notes giving the main results of his investigations. Four of these have now been issued as enumerated at the commencement of the present article, and from the third memoir is copied the figure of the entire skeleton, here reproduced somewhat reduced in size. From these notices is taken the information which follows.

M. Dollo's first care was to determine the species of the Iguanodons with which he has to deal. It will be remembered that his predecessor, M. G. A. Boulenger, who left Brussels to join the zoological staff of the British Museum, recognised among the remains a new species of Iguanodon, characterised by having six sacral vertebrae instead of five as in *I. Mantelli* and four in *I.*

Prestwichii. Professor P. J. van Beneden, however, in the absence of further detailed information, held the opinion that the number of the sacral vertebrae could not be regarded as a specific character amongst Iguanodons, and that our knowledge then on the matter could only be expressed by stating that in the Dinosauria the sacral vertebrae vary in number from four to six. He did not therefore accept M. Boulenger's determination as valid, but regarded the whole of the specimens as belonging to *I. Mantelli*. M. Dollo, however, confirms M. Boulenger's conclusions; he finds that there are two forms of Iguanodons present, a large one and a small one, and the small one is certainly not the young of the large one. It is a remarkable fact that there are no young examples amongst the whole of the Bernissart Dinosaurians, as is shown by the facts that in all of them the cranial sutures are obliterated, and the sternal bones fully ossified, that the neurocentral sutures have disappeared in all the vertebrae and that the osseous tissue is equally dense in all the specimens. Traces of young have been most carefully sought for, but most unfortunately not a bone of a young animal has been found.

The differences between the two forms of Iguanodon are also not merely sexual. They are well marked and certainly of specific value. The number of sacral vertebrae seems to be quite constant in the several species of Iguanodon, and Prof. Marsh, who has had several hundred individuals of Dinosaurians through his hands, representing numerous genera and species, has made use, amongst other characters, of the number of sacral vertebrae present as generic distinctions. After carefully comparing full size drawings of the bones with those of the type specimen of *I. Mantelli* (Owen) in the British Museum, M. Dollo is quite convinced that his smaller form with five sacral vertebrae is identical with this. There are two other well identified species of Iguanodon known, namely, *I. Prestwichii* and *I. Seeleyi* of Hulke. The larger form from Bernissart cannot be *I. Prestwichii*, which has only four sacral vertebrae, but it is just possible that it may be identical with *I. Seeleyi*, since its large bones resemble closely those described by Mr. Hulke as characteristic of that species. There is, however, this remarkable discrepancy. Mr. Hulke discovered bony plates, forming as he believes a dermal armour over the tibia of *I. Seeleyi*. Now amongst the remains obtained from Bernissart are specimens of the integument of both *I. Mantelli* and the larger form. And these indicate that the skins of both these animals were either quite naked or at the most covered with epidermic scabs. M. Boulenger's name, *I. Bernissartensis*, is retained for the larger Bernissart form, for even if *I. Seeleyi* should prove in the end to be identical with it that name must fall through lack of priority. M. Dollo, taking into consideration the results as yet attained by him, characterises the order Ornithopoda of the Dinosauria to which the family Iguanodontidae belongs as follows:—

Ornithopoda.—Foot digitigrade, ungulate, five functional digits on the hand and from three to four on the foot. Pubis projecting freely in front; post-pubis present. Vertebrae solid. Anterior limbs reduced, limb bones hollow. Premaxillaries toothless, at least in their distal region.

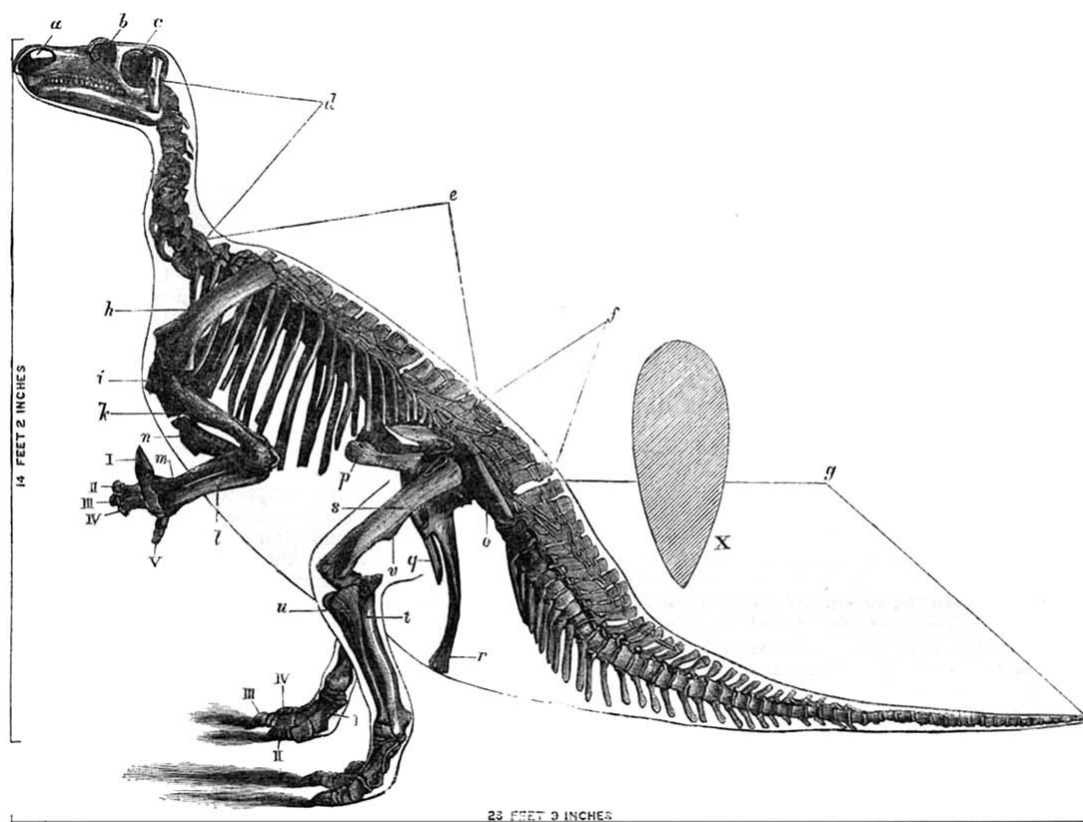
And the family Iguanodontida thus:—

A single row of teeth. Three functional digits on the foot. Two symmetrical sternal plates.

The pair of sternal plates were mistaken by Professor Marsh, who studied them in specimens in the British Museum, for clavicles; and the presence of clavicles was included by him in his definition of the family Iguanodontidae; but in the Bernissart specimens the pair of bones are found in many specimens preserved in their natural relations, and are seen at once to be sternal, clavicles being altogether absent. A specimen is figured by M. Dollo, in which the two sternal bones with the coracoid and scapula of one side are seen *in situ*, all in their proper

relative positions, and the humerus with its head still within the glenoid cavity. The circumstance that in the case of these Bernissart skeletons the bones are so largely preserved in their immediate natural relations adds immensely to their importance, for the position of every bone can be determined with certainty. The nearest approach to the peculiar structure of the sternum in Iguanodon appears to M. Dollo to be that existing in some young birds, especially in *Vanellus cristatus* as figured by Parker. Professor Marsh regarded the supposed presence of clavicles in Iguanodon as an important point in them of resemblance to birds; the point must now drop, but there are abundance of others in the Iguanodon skeleton in which the remarkable

resemblances between the Ornithopoda and birds, pointed out by Professor Huxley with such surpassing sagacity more than twelve years ago, are borne out in a most remarkable manner. Professor Huxley had very imperfect material to guide him in his ideal restoration of the Iguanodon skeleton, and it is wonderful in how few matters of detail his results need correction now that one can stand at Brussels with a perfectly complete skeleton of Iguanodon towering over one's head, and test his results with as it were a complete solution of the puzzle at command. First of all there seems to be little doubt possible that the Iguanodons walked, as he pointed out, on their hind limbs erect like birds, in somewhat the attitude shown in the accompanying figure. Several



Iguanodon Bernissartensis, B'gr. At the Brussels Royal Museum of Natural History. Restored and mounted by M. L. F. De Pauw. Head, *a*, left nostril; *b*, left orbit; *c*, left temporal fossa. Vertebral column, *d*, cervical region; *e*, dorso-lumbar region; *f*, sacral region; *g*, caudal region; *h*, left scapula; *i*, left coracoid; *k*, left humerus; *l*, left ulna; *m*, left radius; *n*, sternum; *o*, left ilium; *p*, left pubis; *q*, left post-pubis; *r*, left ischium; *s*, left femur; *t*, left tibia; *u*, left fibula; *v*, third (fourth) trochanter. I, II, III, IV, V, digits. X, diagrammatic transverse section of the body between the fore and hind limbs.

different lines of evidence, as M. Dollo points out, tend to prove this. Firstly the remarkable resemblances between the structure of the pelvis and the posterior limbs of birds and the corresponding parts in the Iguanodons. The points of resemblance of the ilium and ischium, pointed out by Professor Huxley, are fully confirmed by the Bernissart specimens; with regard to the pubis Huxley only recognised a part in Iguanodon, the post-pubis; and Hulke was the first to give a nearly correct figure of the whole. The actual pubis is very large in Iguanodon, as will be seen in the figure, and projects forwards and outwards, forming an obtuse angle with the post-pubis. Mr. Hulke was therefore not quite correct in his conclusions as to its attitude, and there is no symphysis pubis present; the post-pubis is long and slender, and directed backwards alongside the ischium, as

in birds, for a considerable distance beyond the ischial tuberosity. It is not incomplete, as supposed by Marsh (from the examination of drawings of Bernissart specimens in which it was imperfect). M. Dollo is inclined to follow Professor Marsh in identifying the Dinosaurian pubis with the pectineal process of the pelvis of birds, a conclusion which receives most interesting support in the valuable memoir lately published by Miss Alice Johnson of Cambridge on "The Development of the Pelvic Girdle in the Chick,"¹ in which it is shown that in the embryo fowl the cartilaginous representative of the pectineal process is at first much larger and more prominent in proportion to the dimensions of the pelvis than subsequently, and becomes gradually reduced as development proceeds. The peculiar form of the

¹ *Quarterly Journal of Microscopical Science*, July, 1883.

pelvis is no doubt directly connected with the muscular requirements concerned in the erect posture, originated probably in the Dinosauria, and transmitted to birds, in which it has been improved upon by the elimination, almost complete, of the original pubis through disuse.

M. Dollo takes the view that the post-pubis is a bone peculiar to Dinosaurians and birds. As he pointed out to me in the mounted specimen, probably a male, the aperture inclosed between the two ischiatic bones posteriorly is a very narrow slit through which, if the *Iguanodon* was by any chance oviparous, no egg of size proportionate to the animal could have passed, and it is, he thinks, just possible that in females he may find the ischia bowed so as to inclose a widely open passage above the symphysis.

In a separate memoir M. Dollo has pointed out an additional resemblance in the femur of *Iguanodon* to that of birds to those already pointed out by former observers, namely that the third trochanter present in the former is represented, though feebly, in the femur of many birds. This third trochanter in birds, as he has shown by dissection in the duck serves for the origin of a small muscle first described by Meckel, which is attached to the tail, and by which the lateral movements of the tail are performed; he terms the muscle "caudo-femoral." The great development of the third trochanter in *Iguanodon* must, he concludes, have been in relation with very large similar caudo-femoral muscle concerned in the movement of the immense tail of the animal in the act of swimming. For reasons which he gives, he proposes to call the trochanter in future the fourth trochanter. It is not necessary to enter here into the further well known details in which the hind limb of *Iguanodon* shows intimate resemblance to that of birds, and especially in birds in the young condition.

The reduction of the anterior limbs in proportion to the posterior and their difference in structure are further evidence, though not conclusive, of the erect posture of the *Iguanodons*. In *I. Mantelli* the fore limbs are of about half the length of the hinder, whilst in *I. Bernissartensis* the difference is less, the proportion in length being two-thirds to one.

The reduction in the volume of the head and thorax as compared with those of quadruped reptiles is further evidence on the same side. The head is comparatively small and very narrow in *Iguanodon*, the neck flexible and light as in birds.

One of the most remarkable new points discovered in the Bernissart *Iguanodons*, also a strongly birdlike feature, is the presence in them of a series of completely ossified ligaments stretching along the sides of the dorsal spines of the vertebræ (see figure), and binding the whole dorso-lumbar region into a rigid mass as in birds, whilst the region of the neck and hinder region of the tail are free from any such ligaments. No traces of ossified tendons, such as occur in birds, have been found in connection with the limbs of the *Iguanodons*.

M. Dollo sums up as follows:—"In short the position of the occipital condyle, the length and the mobility of the neck, the rigid attachment of the dorso-lumbar region to the pelvis, the number of the sacral vertebræ, the massive nature of the tail, in fact, the entire structure of the vertebral column, agree in demonstrating that *Iguanodon* was biped in its gait. "But the most convincing proof of all, perhaps, lies in the evidence afforded by the footprints of *Iguanodon* in the Wealden strata. Of the eight Dinosauria known from the Wealden, *Iguanodon* is the only one which could leave tridactyle footprints. M. Dollo obtained a series of casts of the tridactyle Wealden footprints from Mr. Struchman from the neighbourhood of Hanover; choosing one of the right size, he introduced the three toes of the corresponding foot of one of the Bernissart *I. Mantelli*, and also the three metatarsals still united together, giving them a digitigrade position,

the only one in which they would enter the impression, and an exact fit of the whole was the result. There can remain no doubt as to the complete correspondence of the two in the mind of any one who has seen the foot and impression thus fitted together. The hand of *Iguanodon* (see fig.) is pentadactyle, with the thumb transformed into a huge spur which must have been covered with a horny spine when the animal was living. If the animal had walked on all fours, it is impossible but that pentadactyle impressions should have occurred with the tridactyle, but such is not the case. Long series of the tridactyle prints are found without a trace of pentadactyle marks. The arrangement of the tridactyle tracks shows that *Iguanodon* walked on its hind feet, and did not spring like a kangaroo with the aid of its tail. This merely dragged lightly behind and has left no impression in connection with the foot tracks. The spur-like thumbs were formerly supposed to be the cores of horny appendages of the head. They are much smaller in *I. Mantelli* than in *I. Bernissartensis*, and M. Dollo thinks it will possibly turn out that they are larger in the males than the females.

M. Dollo has not yet published a preliminary account of the skull of *Iguanodon*, he is now at work on this subject, and a notice of it will shortly appear. In a popular account of the *Iguanodons* (the last cited in the list) he writes briefly as follows:—

"The head is relatively small, and very much compressed from side to side" (this is a most striking feature when the mounted skeleton is viewed from in front). "The nostrils are spacious and chambered in their anterior region, the orbits are of moderate size, elongated in a vertical direction. The temporal fossa is limited above and below by a bony arch, an arrangement which occurs else only in Hatteria. The distal extremities of both upper and lower jaws are devoid of teeth. They were no doubt during life covered by a horny beak; in the hinder part of the jaws are ninety-two teeth." One of the most remarkable features of the skull is the presence at the symphysis of the lower jaw of a curious separate mass of bone shaped somewhat like a horse's hoof (see figure) which forms the distal extremity of the mandible, fitting in to an excavation on the upper surface of the symphysis. Along its upper rounded margin this bone is dentated. This is believed by M. Dollo to be a bone special to *Iguanodon*, but not without homologues elsewhere which he will in the future point out, and forming part of the lower jaw. Other observers have considered the bone as the intermaxillary, and have thus concluded that the opening of the mouth lay between the bone and the distal extremity of the lower jaw, and that thus the upper jaw was shaped something like a parrot's beak, shutting into a depression at the symphysis of the lower. A slight inspection of the complete cranium and lower jaw cleared completely of the matrix, which M. Dollo has before him, seems sufficient to carry conviction that his view as to the position of the bone and mouth aperture is the correct one.

The roof of the mouth of *Iguanodon* in its anterior region is moulded into rounded, ridge-like prominences, which as M. Dollo pointed out have some curious resemblances in form to those occurring in the corresponding position in a duck. The animal was an inhabitant of marshes—as far as yet known apparently of freshwater marshes only—and fed probably largely on ferns, abundance of which were found with the Bernissart specimen. No results of importance as to this question have as yet been obtained from the examination of their coprolites.

The outline of the body shown in the present figure was roughly sketched in by M. Dollo on request, in order to give an idea of his present conjecture as to the probable shape of the living *Iguanodon*. It is most distinctly to be regarded as merely tentative he reserves any expression of final opinion till the whole material has passed through his hands. On examining the outline, it will be seen that the

Iguanodon probably was shaped, excepting for the long huge tail, which, as Professor Owen long ago pointed out, is shaped like that of a crocodile, being a powerful swimming organ, somewhat like a duck. In accordance with the birdlike modification of the pelvis a large mass of the viscera were post-acetabular in position, as in a greater degree in birds, thus tending to aid the long tail to erect the head and fore part of the body by depressing the hinder region of the spinal column on the acetabular axis as a fulcrum. Like the head the body was very much compressed laterally, so that its transverse section was somewhat as represented in the diagram, X. The neck of the Iguanodon was comparatively slender, and is found to be capable of very free movements. The necks of the fossilised specimens are found to be twisted without dislocation into most varied attitudes. The skin, as already mentioned, was in *I. Mantelli* and *I. Bernissartensis* smooth or covered only with epidermic scales.

Several observers have concluded from the examination of the footprints that a slight web was present between the toes. Judging from observations made on the crocodile and *Amblyrhynchus* of the Galapagos Islands, the animal when in the water, in which it spent a considerable part of its time, when swimming slowly, used for the purpose both its fore and hind limbs and tail, but when going fast fixed its fore limbs close beside its body and drove itself along with its hind limbs and tail only.

M. Dollo suggests that one of the principal advantages gained by the Iguanodons by their erect posture on land was their being enabled thereby to discern at great distances amongst the vegetation the large carnivorous animals of their age to which as herbivora they must have formed a prey. Possibly when attacked they seized their aggressor in their short arms and made use of their thumb spurs as daggers.

M. Dollo is in every way to be congratulated on the results of his investigations, so far as they have yet gone, and his final monograph may be looked forward to as a work of the utmost value and interest, but with the completion of the Iguanodons the working up of the Bernissart find will be anything but exhausted. With the Dinosaurians were found crocodiles and turtles, and a vast quantity of fishes, of which piles upon piles of specimens await his energies in the future. He has already discovered two most interesting new genera of crocodiles, and an equally interesting new genus of Chelonians amongst this material. Every naturalist who has an opportunity should certainly find his way to Brussels to see the skeleton here figured. It is proposed in process of time, when the Iguanodon skeletons are all prepared from the matrix and mounted as far as necessary, to build a new museum of natural history at Brussels in the Parc Leopold, formerly the zoological garden, and in this museum to construct a special gallery to contain all the Bernissart fossils, a rotunda of twenty-five metres in diameter.

H. N. MOSELEY

THE JAVA UPHEAVAL

THE details which have reached us during the past week of the terrible seismic manifestation at Java prove it to be one of the most disastrous on record; probably, moreover, it is the greatest phenomenon in physical geography which has occurred during at least the historical period, in the same space of time. The accompanying sketch-map will afford some idea of the extent and nature of the change which has taken place, and the character of the sea bed and the land in the region affected. Next week we shall attempt to show what light science can shed on the occurrence; meantime we shall content ourselves with gathering together the facts that have come to hand.

The volcanic Island of Krakatoa lies about the middle of the north part of the passage between Java and Sumatra, a passage which has formed an important commercial route. The strait is about seventy miles long and sixty broad at the south-west end, narrowing to thirteen miles at the north-east end. The island, seven miles long by five broad, lay about thirty miles from the coast of Java, and northwards the strait contracts like a funnel, the two coasts in that direction approaching very near to each other. A few weeks ago, as we intimated at the time, the volcano on the island began to manifest renewed activity. The whole region is volcanic, Java itself having at least sixteen active volcanoes, while many others can only be regarded as quiescent, not extinct. Various parts of the island have been frequently devastated by volcanic outbursts, one of the most disastrous of these having proceeded from a volcano which was regarded as having been long extinct. The present outburst in Krakatoa seems to have reached a crisis on the night of August 26. The detonations were heard as far as Soerakarta, and ashes fell at Cheribon, about 250 miles eastwards on the north coast of Java. The whole sky over western Java was darkened with ashes, and when investigation became possible it was found that the most widespread disaster had occurred. The greater part of the district of North Bantam has been destroyed, partly by the ashes which fell, and partly by an enormous wave generated by the widespread volcanic disturbance in the bed of the strait. The town of Anjer and other towns on the coast have been overwhelmed and swept away, and the loss of life is estimated at 100,000. The Island of Krakatoa itself, estimated to contain eight thousand million cubic yards of material, seems to have been shattered and sunk beneath the waters, while sixteen volcanic craters have appeared above the sea between the site of that island and Sibisi Island, where the sea is comparatively shallow. The Soengapan Volcano has split into five, and it is stated that an extensive plain of "volcanic stone" has been formed in the sea near Lampong, Sumatra, probably at a part of the coast dotted with small islands. A vessel near the site of the eruption had its deck covered with ashes 18 inches deep, and passed masses of pumice-stone 7 feet in depth. The wave reached the coast of Java on the morning of the 27th, and, 30 metres high, swept the coast between Merak and Tjiringin, totally destroying Anjer, Merak, and Tjiringin. Five miles of the coast of Sumatra seem to have been swept by the wave, and many lives lost. At Taujong Priok, fifty-eight miles distant from Krakatoa, a sea seven feet and a half higher than the ordinary highest level suddenly rushed in and overwhelmed the place. Immediately afterwards it as suddenly sank ten feet and a half below the high-water mark, the effect being most destructive. We shall probably hear more of this wave, as doubtless it was a branch of it which made its way across the Pacific, and that with such rapidity that on the 27th it reached San Francisco Harbour, and continued to come in at intervals of twenty minutes, rising to a height of one foot for several days. The great wave generated on May 10, 1877, by the earthquake at Iquique, on the coast of Peru, spread over the Pacific as far north as the Sandwich Islands, and south to New Zealand and Australia; while that at Arica, on August 13-14, 1869, extended right across the Pacific to Yokohama (*NATURE*, vol. i. p. 54). It is misleading to speak of such waves as tidal; they are evidently due to powerful, extensive, and sudden disturbances of the ocean bed, and are frequently felt in the Pacific when no earthquake has been experienced anywhere, though doubtless due to commotions somewhere in the depths of ocean. So far these are all the facts that are known in connection with this last stupendous outburst of volcanic energy. It has altered the entire physical geography of the region and the con-